ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS

Eleventh Quarterly Progress Report
For the Period
January 1 through March 31, 1965

Contract No. DA-36-039-sc86741
Order No. 19063-PP-62-81-81

Placed by
Industrial Engineering Division
United States Army Electronics Command
225 South Eighteenth Street
Philadelphia, Pennsylvania

AEROPROJECTS INCORPORATED
West Chester, Pennsylvania

ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS

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The object of this program is to design and construct prototype welding equipments and their associated accessories to perform by ultrasonic techniques the welding operations required in the assembly of electron tubes.

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Specifications SCS-114A, SCIPPR-15
and MIL-E-1/1121A

Report Prepared by: J. W. Thomas

Report Approved by: J. Byron Jones

ABSTRACT

Fabrication of redesigned tooling for use with the 600-watt welder was completed. Satisfactory performance was established during the fabrication of 36 sub-assemblies, and a complete 6080WB electron-tube mount was obtained using the new tooling and a modified assembly sequence. The welder with tooling was then redelivered to Tung-Sol, and operator training was initiated. Also, a precision fixture for crimping stem leads was designed and fabricated.

Components welding has been delayed by the effort required for the redesign of tooling. However, design studies of a 600-watt welder with special low clamping forces for welding frame grids have been initiated.

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PURPOSES

The objectives of this Production Engineering Measure (PEM) are to:

1. Demonstrate the capability limits of ultrasonic welding to join combinations of metallic materials of interest to the electron-tube industry. Devote major effort to making satisfactory joints in materials and geometries which might be difficult or impossible to join by other means.

2. Analyze the welding requirements for a specific electron tube - Type 6080WB. This type was selected by the U. S. Army Electronics Command because it has a record of rejects and failures due to metallic splatter caused by conventional welding techniques and improperly welded joints.

3. Redesign components of the Type 6080WB electron-tube where possible, to permit ultrasonic welding of joints previously found impractical. This effort will result in a tube mount with as many metal-to-metal joints as possible produced by ultrasonic welding so that evaluation of electron-tube performance will not be confused by the influence of metal-to-metal joints produced by other welding or joining techniques.

4. Determine the feasibility of joining 0.003-inch gold-plated molybdenum grid wires to 0.060-inch molybdenum side bars by ultrasonic welding for frame grid manufacture. If successful, redesign applicable components of the Type 6080WB electron-tube mount to permit the use of frame grids.

5. Prepare fixturing and tooling for the Type 6080WB electron tube, compatible with ultrasonic welding equipment.

6. Ultrasonically weld the parts required to assemble electron-tube mounts for the 6080WB tube type, and compare results obtained against similar sub-assemblies made by conventional joining methods. Tests will include strength and environmental tests.

7. Build production ultrasonic welding equipment which will enable an electron-tube manufacturer to make the welded connections in a broad range of electron-tube types.

8. Install the ultrasonic welding equipment in a production company, and produce on a pilot basis with that company's personnel a limited lot size of Type 6080WB electron tubes for subsequent evaluation in accordance with the applicable military specification.

NARRATIVE AND DATA

I. ELECTRON TUBE STUDY

A. Tung-Sol Activity

The 600-watt ultrasonic welder and the redesigned and fabricated tools were delivered to Tung-Sol near the end of this period on March 17, 1965. A training program was initiated for the new operator assigned to the task of electron-tube fabrication. On March 18 Messrs. T. A. Walraven and J. G. Thomas of Aeroprojects explained the tooling changes and demonstrated the assembly sequence through step 6C (see Table I) to the Tung-Sol operator and Mr. Norman Helmstetter. Mr. Max Yarmovsky of Tung-Sol also attended the welding demonstrations.

Since a single operator will carry out the entire assembly sequence, the training for each step will precede the fabrication of each sub-assembly in order to effect a saving in time. Upon partial completion of the sample lot of 6080WB electron tubes through step 6C, the remaining steps of the assembly sequence will be reviewed and demonstrated by Aeroprojects personnel at Tung-Sol in preparation for fabrication of the entire sample lot of completely assembled electron tubes.

B. Aeroprojects Activity

During the last period (Quarterly Progress Report No. 10) the tooling designed for use with the 600-watt ultrasonic welder in assembly of the 6080WB electron tube exhibited service weaknesses when put into production. Tooling redesign and fabrication of revised tooling were completed during this period. Welding tips T-4 and T-5 were evaluated for welding performance, and satisfactory welds were achieved. These redesigned tips are shown in Figure 1.

A fixture for precision crimping the stem leads was also designed, fabricated, and tested. The tool previously used for this operation was a pair of pliers with contoured jaws to provide the crimp. Although this tool offered a satisfactory method, care was required to locate the position and angular orientation of the crimp on each of the eight stem leads (Quarterly Progress Report No. 6, Fig. 8). The new precision crimping fixture, shown in Figure 2, incorporates the punch and die in a spring-loaded precision die set. The glass stem is accurately positioned in a housing mounted on a wayslide. Each stem lead is indexed into position for crimping in two steps: (1) rotation to a stop provided by a detent mechanism within the stem housing and (2) adjustment of the stem lead between the punch and die faces. This fixture thus provides stem leads which contain uniform crimps accurately located in reference to the stem base.

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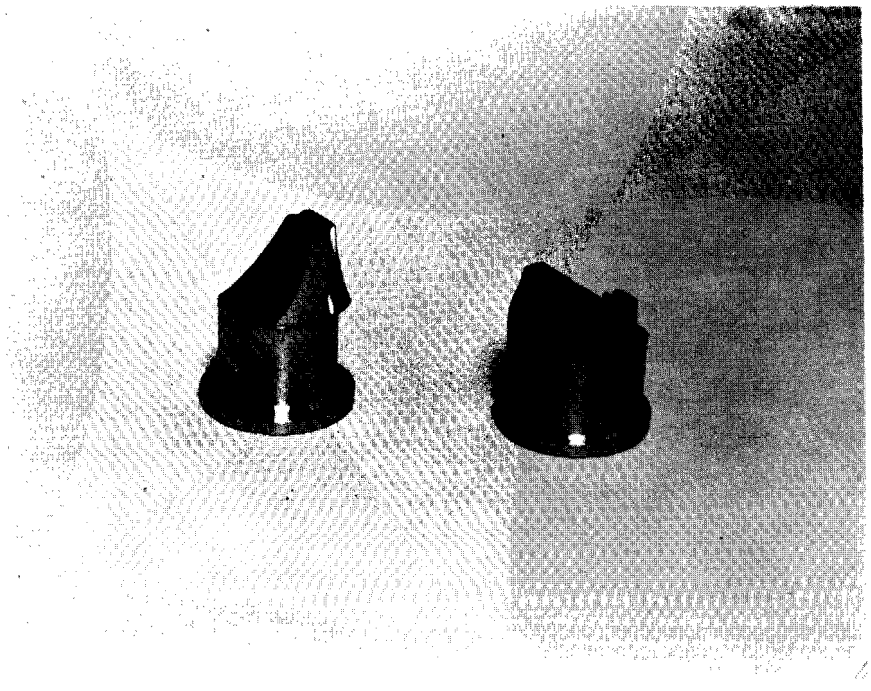

Figure 1

REDESIGNED WELDING TIPS T-4 AND T-5
(Scale 1:1)

W,Mo,A

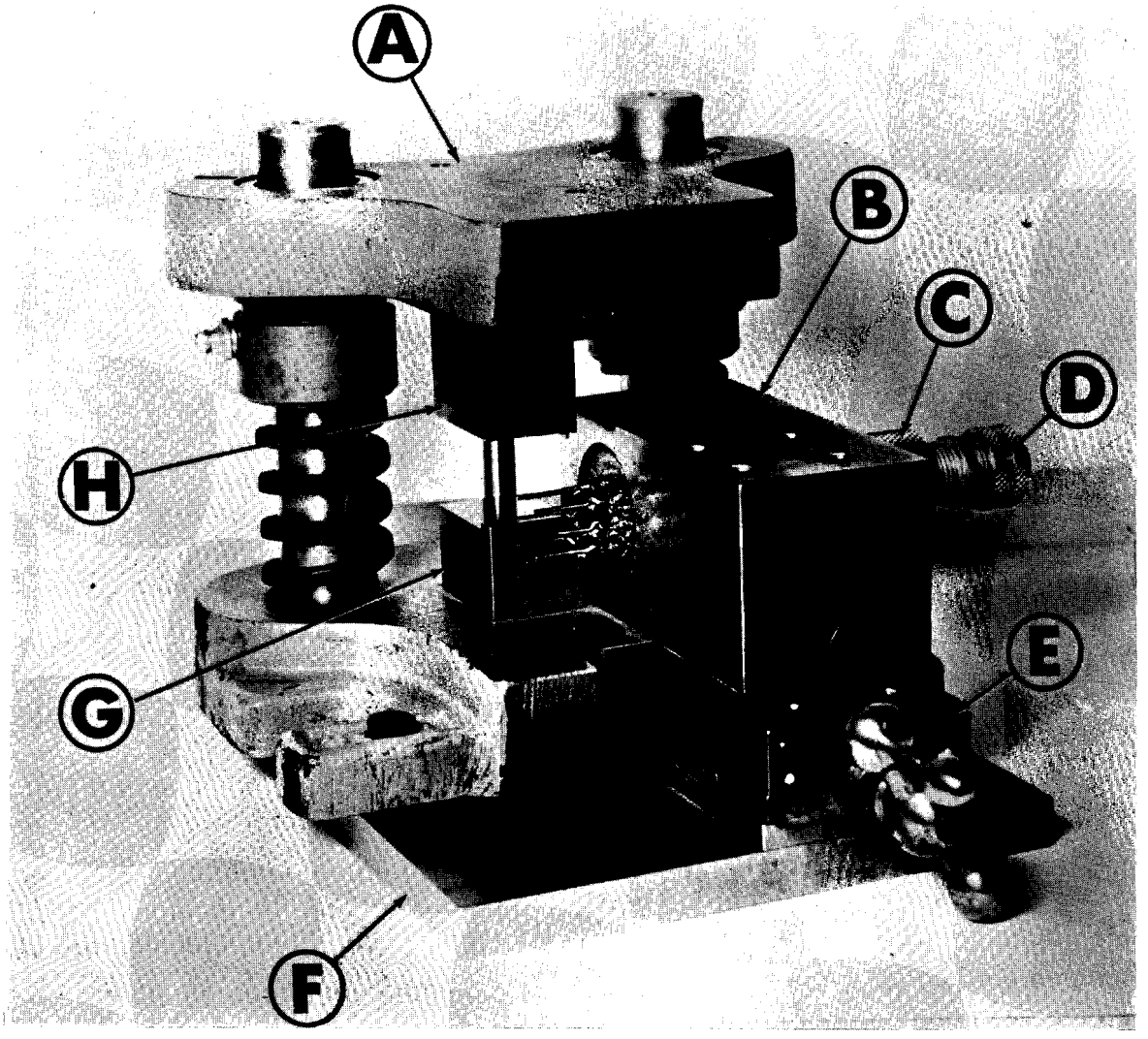

Figure 2

FIXTURE FOR PRECISION-CRIMPING OF STEM LEADS

A - Die Set
B - Bearing Block (with detent in rear for stem holder indexing)
C - Stem Holder (with index slot for stem)
D - Stem Clamp
E - Way Slide (advance and retract)
F - Base Plate
G - Lower Die
H - Upper Die

During evaluation of the revised welding tips and anvil fixtures, the original assembly sequence (Quarterly Progress Report No. 6, p. 12) was modified slightly to facilitate assembly of the redesigned 6080WB tube mount. This modified assembly sequence is presented in Table I. The welding sequence and the conditions for the individual steps were confirmed by the fabrication of 36 sub-assemblies prior to redelivery of the welder with associated tooling to Tung-Sol. The complete 6080WB electron-tube mount shown in Figure 3 was also fabricated.

Anvil fixture A-5, used in the final steps of the assembly sequence (snubbers to snubber support rods - Table I, steps 11A and 11B), has been modified to clamp the snubber support rod during welding. Figure 4 shows modified anvil fixture A-5. Without clamping, the alignment of the support rod is occasionally disturbed, and the rod may break through the retaining hole in the ceramic spacer, necessitating rejection of the entire tube mount. This modification was not completed in time for delivery to Tung-Sol with the new tooling on March 17, but is being completed and will be forwarded to Tung-Sol promptly after its check-out.

II. COMPONENTS WELDING

A. Tungsten-Rhenium Wire Welding

Effort on this phase of the program was curtailed because of the work involved in the redesign, fabrication, and performance check-out of tooling for the 600-watt welder.

B. Frame-Grid Welding

Sixteen wire-wound frame grids (0.003-inch gold-plated molybdenum wire wound on 0.050-inch molybdenum side rods) for preliminary welding studies were received from Tung-Sol on March 25.

Consideration of the size and configuration of the frame grids and the accurate alignment that must be maintained during welding has led to adoption of the approach of welding turns one or several at a time, rather than simultaneously welding all fifty turns required for each side of a complete frame grid. Investigation established the power range (300-600 watts) required for welding two turns simultaneously (Quarterly Progress Report No. 10); proper clamping forces for two turns are below the accurately controllable minimum attainable with standard 600-watt welding machines. An available laboratory welding system will be utilized to explore welding response within the required power range at low clamping forces (less than 70 pounds). Preparation of such a system, utilizing existing components insofar as possible, has been initiated.

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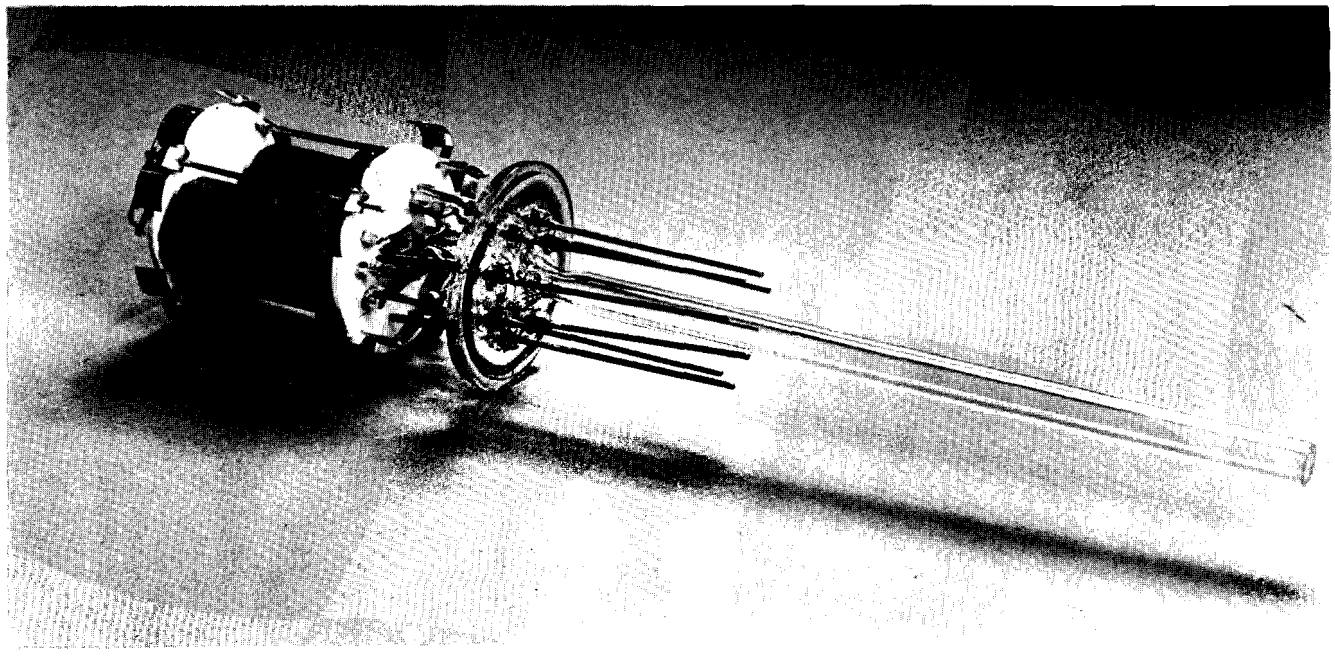

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Figure 3

6080WB ELECTRON-TUBE MOUNT
WELDED WITH THE REVISED TOOLING
(Scale 1:1)

W,Mo,A

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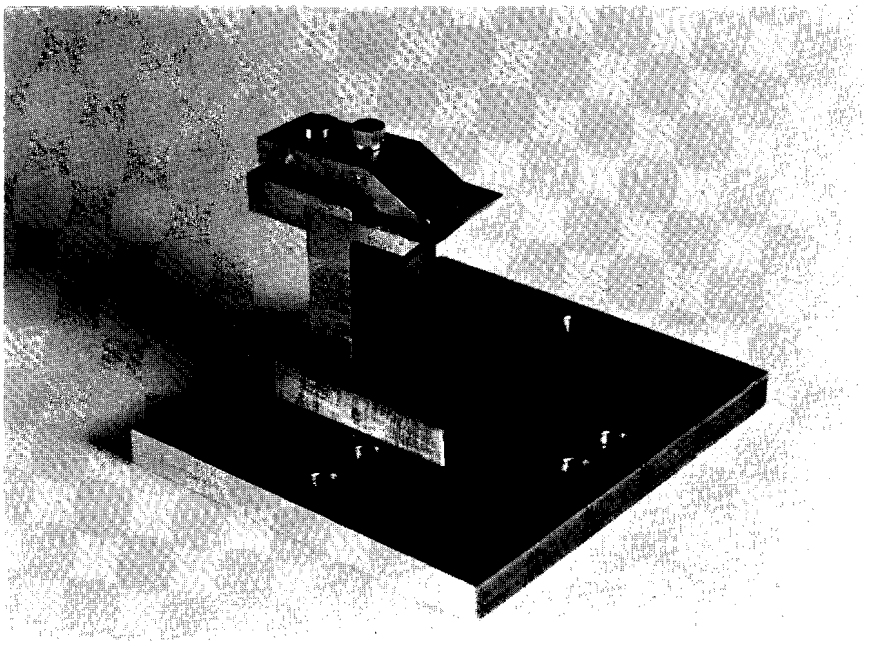

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Figure 4

MODIFIED ANVIL FIXTURE A-5

W,Mo,A

Table I

ASSEMBLY SEQUENCE FOR 6080WB TUBE

Sequence No.	Tip	Anvil	Power Setting	Clamping Force (lb)	Weld Interval (sec)	Operation
1A	T-1	A-1	5	100	0.12	Cathode tab to cathode sleeve - 2 required
Sub-Assembly	-	-				Assemble two sleeves into top spacer
1B	T-1	A-1	2	100	0.10	Looped cathode tab to sleeve
1C	T-1	A-1	2	100	0.10	Repeat above on 2nd sleeve
Sub-Assembly	-	-				Assemble tube cage
2	T-2	A-2	0	600	0	Crimp anode eyelets to anode support rods
3A	T-2	A-2	17	200	0.10	Anode connectors (17876 (17877 to anode support
3B	T-2	A-2	15	100	0.20	Weld anode eyelets to support rods
4A	T-3	A-2	5	100	0.20	Weld grid eyelets (2) to grid support
4B	T-3	A-2	6	150	0.10	Outside grid connector (17882) to grid support
Sub-Assembly	-	-				Assemble R.H. heater connector
4C	T-3	A-2	6	150	0.10	Inside grid connector (17883) to grid support
Sub-Assembly	-	-				Assemble heaters in cathode sleeve
						Insert heater wire sleeves (8)
5A	T-1	A-1	5	50	0.10	Weld alternate heater sleeves to R.H. connector

Table I (Concluded)

Sequence No.	Tip	Anvil	Power Setting	Clamping Force (lb)	Weld Interval (sec)	Operation
Sub-Assembly	-	-				Insert L.H. heater connector
5B	T-1	A-1	5	50	0.10	Weld alternate heater sleeves to L.H. connector
6A	T-4 (Position 1)	A-4	16	100	0.20	Grid connectors to pins 1 and 4
6B	T-4 (Position 1)	A-4	16	100	0.20	Anode connectors to pins 2 and 5 Heater connector to pins 7 and 8
6C	T-4 (Position 1)	A-4	16	100	0.20	Cathode connectors to pins 3 and 6
7A	T-4 (Position 1)	A-4	16	100	0.20	Snubber rod to cathode connector
7B	T-4 (Position 1)	A-4	16	100	0.20	Snubber rod to cathode connector
8A	T-4 (Position 2)	A-4	13	100	0.18	Top cathode connector to snubber rod
8B	T-4 (Position 2)	A-4	13	100	0.18	Top cathode connector to snubber rod
9A	T-1	A-2	6	100	0.10	Cathode tab to cathode connector (Anvil insert inverted)
9B	T-1	A-2	6	100	0.10	Cathode tab to cathode connector (Anvil insert inverted)
10	T-6	A-6	20	100	0.1	Getter to snubber support
11A	T-5	A-5	20	150	0.35	Snubber to snubber supports
11B	T-5	A-5	20	150	0.35	Snubber to snubber supports

III. CONCLUSIONS

Fabrication of redesigned tooling for use with the 600-watt welder in fabricating 6080WB electron-tube mounts has been completed, and satisfactory welding performance has been established.

The assembly sequence has been revised to incorporate the tooling modifications. The welder and associated tooling were delivered to Tung-Sol in March, and operator training and sub-assembly welding have been initiated.

Progress on the tungsten-rhenium wire welding and frame-grid welding has been delayed by the effort required for tooling redesign and testing in connection with the welding operations at Tung-Sol.

PROGRAM FOR NEXT INTERVAL

Activity at Tung-Sol will be concentrated on fabrication of one hundred 6080WB electron tubes for age and life tests. It is anticipated that testing will be initiated during this period.

Activity of Aeroprojects will be concerned with establishing the welding conditions and tooling required for welding the frame grids. Sample welds will be examined metallographically, and joint strengths will be compared with those obtained by the gold-bonding technique presently used. Welding equipment derived from the frame-grid investigations will be used to prepare, for testing, weld samples of 0.003-inch tungsten-rhenium wire bonded to 0.060-inch sheets composed variously of tungsten, molybdenum, and nickel.

PUBLICATIONS AND REPORTS

No publications or reports were issued during this period. The following trips were made in connection with this project:

Technical consultation between Messrs. M. Yarmovsky and N. Helmstetter of Tung-Sol and Mr. J. G. Thomas of Aeroprojects was held on March 18, 1965, at Tung-Sol, Bloomfield, New Jersey.

Mr. T. A. Walraven of Aeroprojects installed the 600-watt welder on the Tung-Sol premises on March 17. On March 18 Messrs. Walraven and Thomas demonstrated the operation and assembly sequence for the Tung-Sol Operator. Messrs. Yarmovsky and Helmstetter witnessed the welding demonstrations and operator training.

Mr. Harry Shienbloom and Mr. J. G. Thomas held technical consultations and reviewed the program status on January 26 and on March 2 at USAECOM headquarters, Philadelphia, Pennsylvania.

TECHNICAL MAN-HOURS

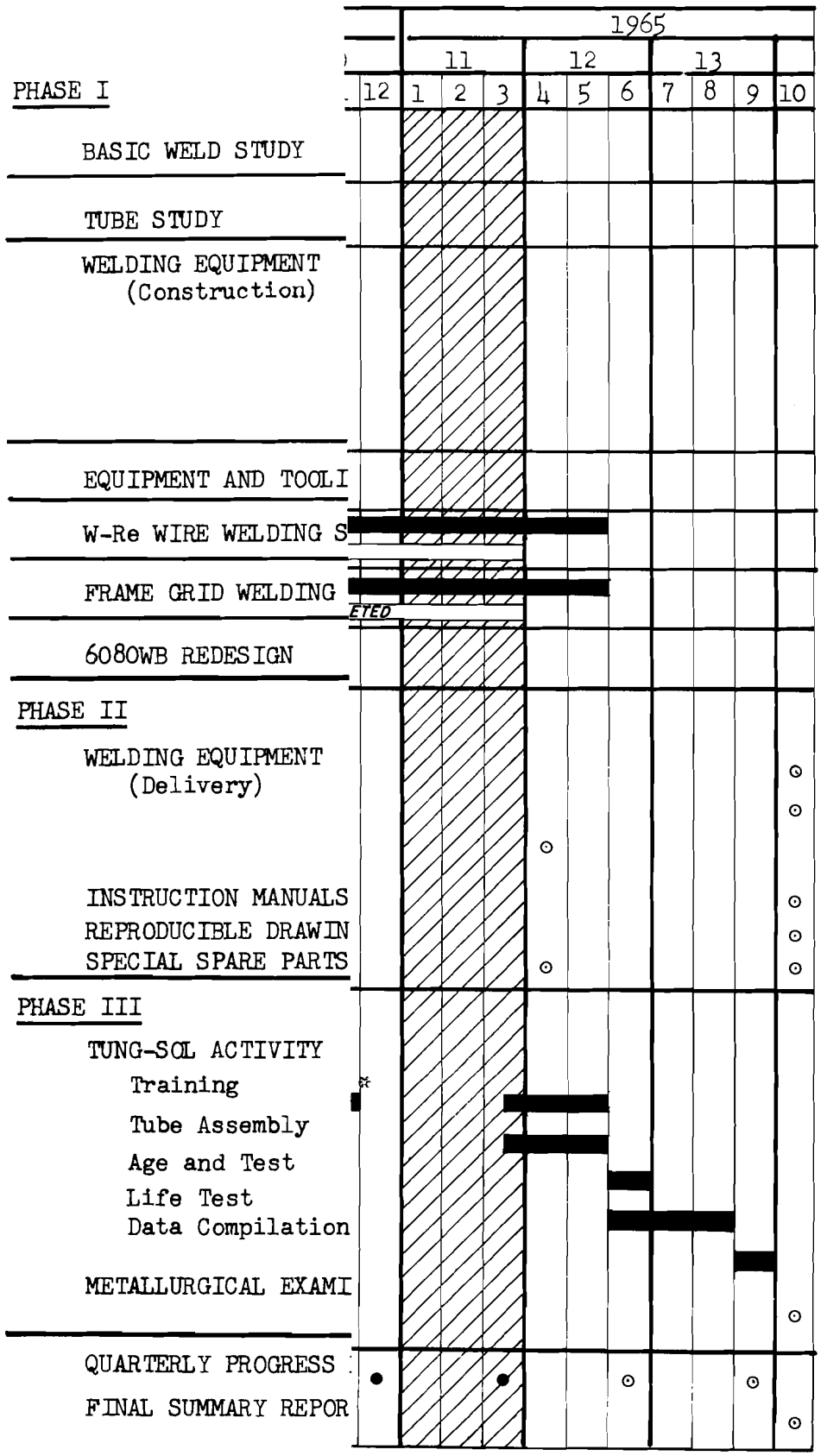
EXPENDED DURING THIS REPORT PERIOD

Aeroprojects	Project	Hours Expended During This Report Period
J. G. Thomas	Project Engineer	24-1/2
T. A. Walraven	Senior Welding Technician	36
A. L. Fuchs	Chief Design Engineer	22
Engineering		102
Shop		27-1/2
	Sub Total	212

Tung-Sol Electric Incorporated

N. Helmstetter		0
	TOTAL	212

Technical surveillance of this contract is under the control of the Industrial Engineering Division, USAECOM, Philadelphia, Pennsylvania 19103. For further technical information contact Mr. Harry Shienbloom, Project Engineer (telephone number: area code 215, KI6-3200, extension 2137).



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